



# THE GEOLOGICAL SOCIETY OF MINNESOTA

## News

*Volunteer  
opportunities,  
field trips,  
lectures, and  
public service,  
since 1938*



GSM President, Dick  
Bottenberg

### From the President's Desk...

2017 is shaping up to be another great GSM year! Although it is wintertime, GSM members in town can be geologically active with lectures and field trips as we get ready for spring and summer adventures.

The new year's lecture series started with two heavily attended lectures. In fact, 145 geological enthusiasts attended Dr. Randy Strobel's talk on the Geology of Mississippi River Gorge in the Twin Cities. This is the largest crowd we have had in over five years. Steve Erickson has scheduled a solid lecture series, so please keep coming!

Field trips for 2017 will also be exciting. Dave Wilhelm has already taken the GSM to the Wildlife Science Center in Columbus, MN and we will visit the American Engineering Testing Company in St Paul early February. Randy plans to lead three local trips to explore the Mississippi River gorge this summer (including a bike trip) and Dave Wilhelm is planning a solar eclipse watching event and another possible visit to Eagle Lake Observatory. Additionally, Becky Galkiewicz is providing opportunities to check out GSM geological markers as you explore Minnesota this summer.

I look forward to working with the Board at our February meeting as we establish the GSM's goals for 2017.

We are working on geologic interpretative markers for Minnehaha Falls, completing a GSM marker survey and database, refining our approach to recording the lectures, and looking at determining ways for the GSM to support worthy causes.

Thanks to all the volunteers and leaders who make the GSM successful. Gotta dig it!

Dick Bottenberg

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from the GSM archives:  
Field trip the Black Hills,  
South Dakota, circa 1947



## GSM News

**Officers:**

Dick Bottenberg, President  
Theresa Tweet, Vice President  
Mary Helen Inskeep, Treasurer  
Open Position, Secretary

**Board Members:** Kate Clover, Dan Japuntich, John Jensen; Ruth Jensen; Deborah Naffziger; and Dave Wilhelm

**Editors:** Theresa Tweet; Mark Ryan; Harvey Thorleifson; Rich Lively

**Web Site:** [www.gsmn.org](http://www.gsmn.org)

The Geological Society of Minnesota is a 501(c)3 nonprofit organization. The purpose of this newsletter is to inform members and friends of activities of interest to the Geological Society of Minnesota.

Send all GSM membership dues, change of address cards, and renewals to: Joanie Furlong, GSM Membership Chair, P.O. Box 390555, Edina, MN 55439-0555; Membership dues are: \$10 Full-time students; \$20 Individuals; \$30 Families

GSM News is published four times a year: **February 15, May 15, August 15, and November 15.** Deadline for article submission is the first of the month, before the date of publication.

**Newsletter contributions welcomed**

Of interest to our GSM enthusiasts: While out and about enjoying your vacation time – when you visit a site that you find interesting, please consider sharing your experiences with us by writing up a few words and sending it to Theresa Tweet at [phoenix8185@gmail.com](mailto:phoenix8185@gmail.com). Thank you in advance!

**New GSM Members!**

Howard Bergstrom, Minneapolis  
Elaine Heisterkamp & John Renwick, Minneapolis  
Carol Perkins, Arden Hills  
Jason Harvey, Minneapolis  
Elliot Johnson, Coon Rapids  
Don McIntire  
Terry & Kym Smith, Woodbury  
Bernie Waibel & Donna Rodel, Minneapolis  
Glenn Lee, Northfield

**GSM Board Membership**

The GSM Board consists of members who have a special interest in advancing the goals of our society,

including lectures, field trips, and community outreach. The Board currently has nine members. Our bylaws limit the terms of Board members to four years, to encourage a turnover of perspectives and ideas. The Board typically meets quarterly, on the second Thursdays of February, May, August, and November, or a different date if conflicts arise. We typically meet from 7 to 9 PM at the Minnesota Geological Survey at 2609 W Territorial Rd, St. Paul MN 55114.

Board meetings are open to all members of GSM. So, whether you are a new member of GSM or have been a member for many years, if Board membership is something that might interest you, or you are just curious to see what our Board does and how it works, we encourage you to attend a meeting. And, if you have a topic you would like the Board to consider, please contact Theresa Tweet at [phoenix8185@gmail.com](mailto:phoenix8185@gmail.com).

**Position Notice:** The GSM is seeking a Secretary willing to take notes at four Board meetings per year.

We are also seeking someone that will oversee the GSM Student Outreach program, in which geology undergrads speak in schools. Training will be provided and the activity occurs mainly between February and May.

Please contact Theresa ([phoenix8185@gmail.com](mailto:phoenix8185@gmail.com)) to discuss your potential willingness for either position, both of which will be fun!

**Member Spotlight; Sherry Keesey**

*How long have you been a GSM member?* I joined in September of 2010. I barely raised my hand to be treasurer when Janine spotted it. I had the job before the meeting began.

*How did you get interested in geology?* I got my interest in rocks from my brother Dave, walking the San Andreas Fault, and a visit to Quartzsite, Arizona

*What do you dig about the GSM?* I joined for the field trips but fell in love with the friendly, interesting members who know so much and put up with my questions.



What a great, FUN group!!! And great lectures thanks to Steve Erickson



*The young man is my grandson Zack Keesey. The picture was taken in 2103 on the Mohave Desert trip with Rand. We have just climbed a volcano known as Amboy Crater. Joanie took the picture.*

As many of you have probably noticed, the GSM has added a new column to our Newsletter called "GSM Member Spotlight". The questions are easy (see below), and those that have been a part of this have said that it has been fun. So please, if you are contacted and would like to take part, let us know. If not, that is okay too, let us know.

1. How long have you been a GSM member?
2. How did you get interested in geology?
3. What do you dig about the GSM?

And if you would have a picture of yourself or family members enjoying geology to add to the article, this would be terrific!

### Holiday Celebration – 2016

One of the largest GSM Holiday Celebrations to date took place at the home of Ed and Sandy Steffner on December 10<sup>th</sup>. The main meal consisted of a delicious ham, assorted appetizers, salads, and desserts. The food was



scrumptious! There was excellent conversation, and we got to know some of the new

members and enjoy the company of longtime members. Add to this Ed Steffner's flair for the piano and some holiday favorites with a geology slant on them, and you have an incredible evening for sure. Thanks again Ed and Sandy for hosting such a wonderful evening and helping us to ring in 2017 in style.

Theresa Tweet

### Notes from the Past From the FALL 1980 GSM Newsletter

**First Field trip Worthwhile:** At long last I was able to connect with a field trip. After many, many classes in geology, field trips are a must, as well as a good reason to join the Geological Society. With some trepidation, I arrived at the Macalester parking lot at 8:00 a.m. on a bright Saturday in July. The group was friendly, helping people to get acquainted, and arranging rides with those who would drive in the caravan. Dr. Webers had an excellent trip planned and I enjoyed his lectures along with nature's wonders. Being in the field certainly makes it easy to commit the subject to memory. I managed to resist the temptation of adding to the boxes of fossils already in my basement. The ride home through Minnesota's beautiful farmland was another plus. All in all, a delightful day.

Bertha Ames

### GSM Spring Banquet

Please join us for the final lecture of the 2016-2017 Season, the GSM Spring Banquet and Lecture on Monday, May 1, 2017, at U Garden Restaurant, 2725 University Avenue SE, Minneapolis, Minnesota, 612-378-1255. Steve Erickson, M.Sc., will speak on "Boom Times, the Early Days of the Oklahoma Oil Industry". Buffet dinner will be at 5 PM, and the talk will be at 645 – 8 PM. Dinner will be \$11:50 + tax + tip, pay at end, one check per table. Buffet includes hot tea and water, other beverages extra. Ordering from the menu at the posted price is an option. Checks are not accepted. Parking is at rear. See

[www.ugardenrestaurant.com](http://www.ugardenrestaurant.com) for directions. The Green Line passes nearby. For updates, check the GSM web site or Facebook. See you there!

### ILSG

The 63rd annual Institute on Lake Superior Geology (ILSG) conference, co-Chaired by Anthony Pace and Ann Wilson of Ontario Geological Survey and Ted Bornhorst of Michigan

Technological University, will take place May 8th to 12th, 2017, in Wawa, Ontario. The meeting will consist of two days of technical sessions on the 10th and 11th at the Michipicoten Memorial Community Centre, and six field trips, three before the technical sessions on May 8th and 9th, and three afterward on the 12th. Please visit <http://www.lakesuperiorgeology.org/> for details, and hope to see you there!

### GSM Field Trips and Tours

We have had one excursion since the last Newsletter. On Saturday afternoon, January 28, Dave Wilhelm arranged a tour of the **Wildlife Science Center** (<http://www.wildlifesciencecenter.org/>) in Columbus, MN. About 40 GSM members and guests participated, including some young children. The temperature hovered around 25 degrees, so the animals were fairly active to maintain body heat. We saw, heard, and smelled gray & red wolves, coyotes, foxes, a mountain lion, bobcat, porcupine, and screech owl, and got detailed explanations of their behaviors and interactions. And we were exhilarated by choruses of wolf howls a few times during our visit. The Center will be moving in March, so that was a last opportunity to tour the present site. See our web site for photos from this tour.

In this issue, Deborah Naffziger reports on the second half of our four-day July 2016 field trip to various sites and facilities on the **Mesabi Iron**



*GSM members at the Wildlife Science Center*

**Range;** see the previous Newsletter for her report on the first half. Thank you, Deborah, for sharing this trip with the rest of our members.

I am in the process of summarizing our past field trips on the GSM web site. To date, I have gotten back to 2011, and there is preliminary information

back to 2003. To see these, click "GSM Field Trips" in the left margin of the home page, then click the year. These summaries are a good way to learn more about GSM.

I continue to plan our field trip to see the **total solar eclipse** on August 21, 2017. If you are interested and have not yet responded, do so immediately to me at [dewilhelm53@msn.com](mailto:dewilhelm53@msn.com), as I am directing further e-mails on this subject only to those who have indicated interest.

Randy Strobel will lead field trips to **Minnehaha Falls** and the **Minneapolis riverfront**, as follows to his February 6 lecture. As dates and other details are determined, we will make them available by e-mail and web site.

To see other trips we are considering, select the Field Trips link on our web site home page and click 2017. Members will receive e-mail on these possibilities and any others that arise when there is sufficient detail. As always, contact me with ideas for other field trips that would interest you.

Dave Wilhelm, GSM Field Trip Coordinator

### Iron Range Tour Days 3 & 4

On Saturday, July 23<sup>rd</sup>, 2016, 27 club members gathered for a day of rocky fun at the Hill Annex Mine in Calumet, Itasca County. I was excited, because I had toured the mine in the 1990's with my late husband, and it was a great tour then. I discovered things have changed greatly since the 1990's.

We took a bus to a Cretaceous waste rock pile within the mine. John Westgaard from the Science Museum explained that this was the 90 million year-old Coleraine Formation above the ore, which had been blasted and removed as overburden, so it is now a fossil hunting site. This was the first time that I encountered fossil hunting from a rubble pile, and since it was a marine environment, bivalves were the main fossils that were found. Minnesota has few Cretaceous fossils, but more species are being discovered every year from this site. One dinosaur so far, but there is always hope for more...

John was accompanied by students who helped identify what we found. They had a nice little exhibit of fossils from the site, to give people an idea of what they were looking for.

None of us made any grand discoveries, but most everyone managed to leave with some fossils for themselves. Many of us just picked rock specimens, and that was ok, too.

After an hour, the bus returned and shuttled some of us back to the museum for an afternoon mine tour.





John Westgaard

While waiting for the tour to start, we washed up with Lava soap, ate some lunch, and explored the museum. The museum was well researched and labeled, and the gift shop was nice. The mine tour was nearly filled, so only a few from our group got onto the first bus.

The Historical tour lasted 90 minutes, and we saw lots of old machinery and buildings. Greg Brohman

underwater. The lake is rising, as the cost to keep the



Hill Annex Mine Club House Museum

pumps going was prohibitive. Our guide had worked in the mine from 1974 to when he retired in 2009, so he was full of anecdotes and stories and knew what it all was about. We did miss one site in the mine



Hill Annex Mine Fossils

was the guide and his website is

<http://nashwauk.net/HILLANNEXIRONMINE.html>.

The bus had a flat tire -apparently it went flat just before our tour – but it was fixed and we still soldiered on.

The bus stopped at an overlook, where we learned the mine was mostly underwater now. Indeed, where I had walked on the floor of the mine and picked tailings in the 1990's, was now about 30 feet



Overlook of the Hill Annex Mine



Fossil hunting at Hill Annex Mine



Tour bus

because the driver was unsure the tire would be safe going up and down.

Greg Brohman



At another stop, Greg walked us to an outcrop where he kindly pulled banded iron from the wall for us to take home. Usually in parks you cannot take anything, but in the mines, it's all different. The rocks are everywhere, so taking some home won't make a dent.

After we returned to the museum and park, the rest of our group took their mine tour.

Hill Annex would be a nice half-day weekend excursion, if you aren't into spending hours digging for fossils. You will want to book beforehand on the tours, as they fill up fast.

Saturday night we ate at the Brick Yard, a bar in Hibbing. Again, good bar food and many TV's to



*Collecting rock samples at the Hill Annex Mine*

watch various sports events. There are sure a whole lot of sports channels nowadays. The bar burned down August 29<sup>th</sup>, so don't plan on eating there any time soon. We said goodbyes as several people were going back home the next morning. Going on this trip



*Humphrey Swirl (spiral) Separator*

but never visited the lab.

We gathered up top, got our tickets, and toured the aboveground facilities. I watched as the person operated the hoist, bringing people down to the tour level, and back up again. It's a giant hoist with a big

cable; it spools off one end and back onto the other. Level 27 is the 'bottom', and that's where we were headed. Fifteen intrepid people decided to descend almost a half-mile underground for the tours.

The Soudan mine was in operation from 1882-1962 and was considered a Cadillac of mines - most safe, most productive, and best run. It was a safe mine, with no water or gases to endanger the miners. It started as an open pit mine which is still visible above ground, and quickly moved underground. This is the most iron-rich ore—specular hematite is 70% iron. With taconite and the rising costs of underground mining, it became obsolete and was closed for mining, but several years later was reopened as a museum, through the efforts of former miners.

We all watched a video, heard a brief chat by our tour guide, and donned hard hats. We all squished into the hoist cars, and we were half the number of miners that would have normally occupied that space. They sure squeezed them in tight.

Down on the bottom, after three ear pops, we rode the train cars to a mining site, and it was very pretty with the ore and various rocks. There's still plenty of ore available, it just isn't commercially feasible to mine anymore. Taconite relies on magnetic sorting, and specular hematite isn't magnetic. The mine tour seemed to be shorter than before, or maybe I was already familiar with the spiel. Just being underground is a treat for me; caves, mines, whatever, I love being underground.



*Soudan Mine Headframe*

But after the mine tour the geology group was herded off to the physics lab, across from the mine area. Years ago the lab was on level 22, but it was moved down to 27 in an area of greenstone, which is softer and safer to drill than the iron ore. This was one of the last tours of the Physics lab, as they were dismantling the detector and moving out. By the time you read this, it will all be removed, and hopefully



some other science group will want to rent the place, because it is a very nice facility. The DNR owns the facility—the physics people only leased the space.

The space is very nice, heated and dry, and shirtsleeve comfortable. They needed a climate controlled environment for both the detector and experimenters. Everything was constructed in pieces, hauled down in



*Soudan Mine, Level 27*

the hoist, and assembled below.

The group opted for the longer, geekier physics lecture, so the guide went into a lot of detail. The whole theory is that neutrinos are small sub-atomic particles, emitted by the sun and other stellar objects. But they are very small and very fast and very difficult to detect. So it was surmised, that a detector a half-mile underground would be better able to detect neutrinos because all that rock would filter out the rest of the atomic particle 'noise'. They originally started detecting neutrinos in the 1990's, with a 350 ton

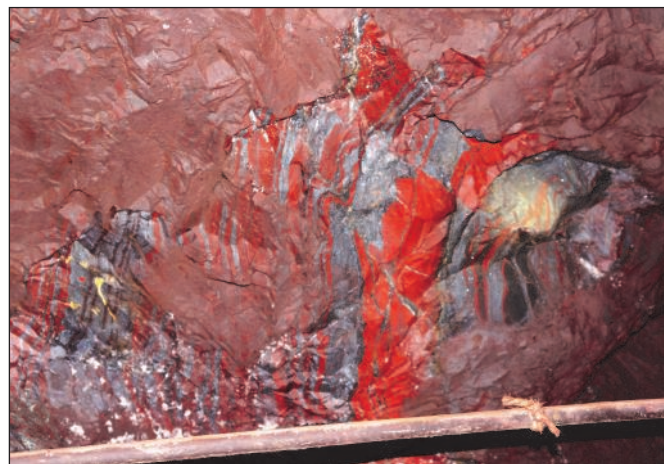


*Soudan Mine, Physics lab area*

machine. Their first detector was assembled and set to run and they detected exactly—none. So after a few years, they decided to build another-larger-1000 ton detector. After that was assembled and turned on, it detected exactly - none again. So being theoretical

physicists and determined to detect neutrinos, after a few more years they built a third detector, but this time changed the arrangement. A facility at Fermilab outside Chicago which generates neutrinos beamed them toward Soudan, where the newest detector found about one neutrino a day - a great improvement over none at all.

It was explained that there are something like 12 subatomic particles; up quark, down quark, and the electron are the three most people deal with in chemistry (being the ones that constitute the proton, neutron and electron). The rest are physics and have little to do with chemistry (that we know of at present).



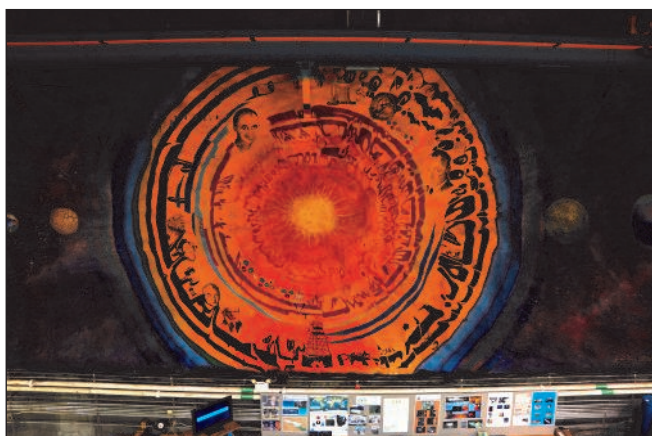
*Soudan Mine, Banded Iron Formation*

You never know what they will discover in the future...) Neutrinos come in three flavors, and can change flavor as they travel from Chicago to here. They are weird and sneaky—as are most of the non-chemistry subatomic particles. The rest of the physics talk was interesting but more technical than my note-taking ability was up to. Now that the Soudan Physics Lab has closed down, a recently built above ground facility located about 40 miles north of the mine has taken over detecting neutrinos from Fermilab.

A beautiful, commissioned mural by artist Joseph Giannetti graced the wall of the Soudan Mine Physics Lab. It had all sorts of physics in-jokes and lab in-jokes and a nice display explained them all underground. You could get pictures of the mural in the gift shop, but not nearly large enough, and not with all of the geeky explanations. That would be a great wall poster with the explanations. The gift shop was very nice, with some fine displays of minerals found in the mine, and lots of interesting things to buy – of all of the places that we visited; it was the best gift shop of them all.

After the mine we drove to the surface outcrop of banded iron, and some people stayed and ate lunch there.





*Soudan Mine, Physics mural*

The trip back to the Cities was uneventful, and a good time was had by all. We were pooped, and had our boxes of rocks, and had a very good time over the weekend. I would highly recommend any field trip



*Soudan Mine, Tour group at a BIF outcrop*

like this. It was not that expensive with sharing a room, and well worth the cost. And I made many new friends, so it was a great weekend for sure!

Deborah Naffziger

### **This Year's Total Solar Eclipse**

This summer, the United States will experience its first total solar eclipse in more than thirty years. On August 21, 2017, the Moon's shadow will speed across the entire length of the continental United States from Oregon to South Carolina, and anyone lucky enough to position themselves within the path of totality will be able to witness one of the world's greatest natural phenomena; one that can truly be described with the much overused adjective "awesome".

On average, a total eclipse of the sun occurs about every

18 months but the majority take place in out of the way locations. Most everyone has witnessed a partial solar eclipse at some point in their life, an event that can be certainly interesting, but to paraphrase writer Annie Dillard from her 1982 essay "Total Eclipse": seeing a partial eclipse compares to seeing a total eclipse the same way as flying in an airplane compares to falling out of one.

Any single spot on Earth can expect to experience a total eclipse about once every 300 years. Next year is our turn, so in early preparation for next summer's grand



*Partial solar eclipse, Lake Calhoun, May 2012*

event, I offer here my own recollection of the total solar eclipse I saw in Mexico back in 1991.

#### **Puerto Vallarta Mexico, July, 1991**

As our plane taxied toward the terminal, my brother, Pat, and I wondered if we hadn't made a big mistake coming to Puerto Vallarta for the so-called Eclipse of the Century. Out the rain-streaked window, we stared at the dense clouds shrouding the city's hillsides. "We should have gone to Hawaii", Pat mumbled.

Hawaii, the site rated best for favorable weather, had been ruled out because of the cost involved. Predictions of horrendous traffic jams down the Baja Peninsula precluded any thoughts of driving in from California. So there we were in Puerto Vallarta, Mexico, under a gloomy, dark sky wondering if we had made the right decision. The Pacific coast city was fairly inexpensive to reach by air, and although it would be just outside the range of totality (the sun would be 99 percent covered) we planned to rent a vehicle and head north toward the shadow's centerline, and hopefully toward better weather.

Our plans changed after we learned of an expedition in town called the Eclipse Edge. Led by astronomer and veteran eclipse chaser Tom Van Flanders of the U.S. Naval Observatory, the group specialized in studying



the phenomena prevalent during totality near the predicted edges of the umbra, the eclipse's darkest



*Crescent shadows, waning solar disk, July 1991*

shadow (the penumbra being the lighter shadow). After settling in our hotel, we walked to the Sheraton where the expedition was headquartered. We looked over their information, and decided to sign up. For \$100 each we'd get transportation to a viewing site, access to telescopes, and more scientific knowledge than we could ever use. Most importantly, the expedition would have contacts all along the shadow's path in case inclement weather forced us elsewhere for clearer skies.

On the morning of the eclipse, as the expedition's nine buses left the hotel, clouds still banked above the mountains, but the sky over the Pacific was clearing. Within an hour we pulled into Sayulita, a quaint fishing village about 30 kilometers north situated on a spectacular white beach just four miles into the shadow's predicted path. Our arranged setup site was the local schoolyard consisting of an open-air building with wooden desks overlooking a walled-in sloping playground area. Expedition participants scrambled to set up their gear while Pat and I wandered about checking out their equipment. Some had images of the sun projected from their telescopes onto cardboard for easy viewing. Others struggled to balance their tripods so scopes and cameras could be aimed properly. Every 10 minutes radios broadcast the exact Universal Time, marking the countdown to the event.

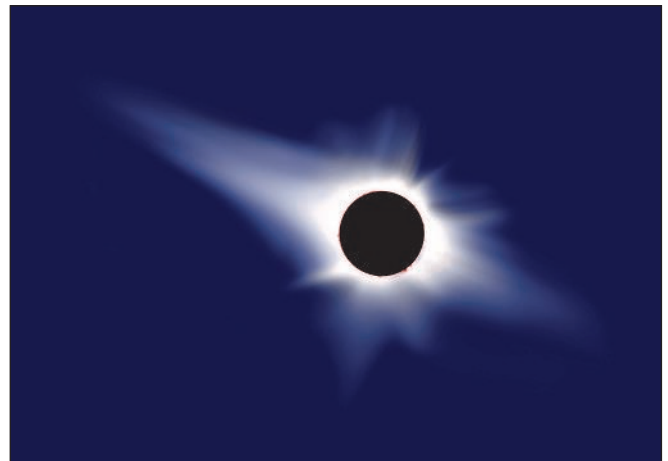
Suddenly shouts of "First Contact" rippled across the school yard.

A total eclipse is measured by four main events known as contacts. First Contact marks when the moon's limb (edge) first touches the sun; Second Contact marks the start of totality when the sun is completely masked by the moon's disk; Third Contact, the end of totality, and Fourth Contact when the moon and sun separate again. The entire sequence takes about 3 hours.

By eleven o'clock it was hot, so Pat and I moved to the palm-studded beach located some 200 yards away. Fewer

people and fewer telescopes were there, but the cool Pacific breeze made it much more comfortable. Nearby, someone had laid out a white bed sheet hoping to catch sight of shadow bands, an eclipse phenomenon where ambient light wavers like the sunlight seen at the bottom of a swimming pool. I studied the sun through the piece of #14 welder's glass I had brought with me. Eye protection is essential during the partial phases of an eclipse. Even at 99% percent covered the sun can cause eye damage if viewed directly with the naked eye.

As the solar disk diminished, there was a noticeable drop in air temperature, and the daylight around us took on an unnatural bluish hue. Palm fronds overhead cast tiny images of the crescent sun in their shadows across Pat's sandals. The thin layer of clouds which had been a concern all morning was beginning to dissipate. About 10 minutes before totality, the planets Venus and Jupiter became visible in the darkening sky. Just offshore, the pelicans which had earlier been fluttering noisily above the surf and diving for fish, were now floating quietly on



*The sun's corona becomes visible*

the surface. Overhead, as the last remnants of the sun disappeared behind the moon's disk, Baily's Beads appeared. These tiny bursts of light are caused by the last bits of the sun's surface peeking through the mountains and valleys along the moon's rim, signaling the start of totality. When the last visible glint of sunlight flashes brilliantly, producing the Diamond Ring Effect, shouts of excitement and disbelief rise from the beach and schoolyard as the sun goes dark and the magnificent corona suddenly appears. And the sight is truly incredible. There's no sun where the sun should be! Instead a black hole hangs in its place and it's the blackest hole you've ever seen. The red chromosphere, peppered with prominences, rings the edge of the blot. From that a ribbon of steel-gray gossamer pulsates in all directions and seems to breathe as if alive.

This is the corona, the sun's outer atmosphere, normally obscured by the brightness of the solar disk. Shouts of awe and amazement - including plenty of expletives -

can be heard everywhere. I lay on my back snapping one photograph after another, but pause long enough just to gaze in wonder. A long coronal streamer extends northwesterly at least three solar diameters in length, waving like a banner, and it's truly the most amazing thing I've ever seen. It's as if a giant eye is staring down at me. I take a couple more pictures, then another Diamond Ring Effect occurs, marking Third Contact, and suddenly totality is over. Cheers and applause rise up from the beach. Strangers shake hands, hug, and give each other pats on the back. None of us can believe what we've just seen. None of us will ever forget it.

After totality, events repeat themselves in reverse order, so Pat wandered up the beach in search of shadow bands while I trudged back to the schoolyard hoping to retrieve my camera bag. People were already packing up their gear, getting ready to leave. But everyone was in a state of dazed euphoria. The euphoria lingered on the bus ride back to Puerto Vallarta, and on our flight home the next day. Even days later, as I drove downtown to have my photos developed, I was overcome with strong emotions thinking about what I had witnessed.

Many years later, while standing in line at a computer store, I noticed the guy ahead of me was wearing a black t-shirt with "Eclipse '91" written across the back. When I



3rd contact diamond ring, end of totality

asked him about his experience, he shook his head with regret, then turned to face me. On the front of his t-shirt it read: "I went to Hawaii to watch the clouds get dark." He had seen nothing. He had missed the Eclipse of the Century, and I felt

kind of bad for him. Let's hope

everyone's experience next summer will be otherwise.

The following link contains excellent information about the shadow location in each state where totality can be viewed during next summer's total solar eclipse:

[http://www.eclipse2017.org/2017/path\\_through\\_the\\_US.htm](http://www.eclipse2017.org/2017/path_through_the_US.htm)

Additional Eclipse Info:

<http://eclipse.gsfc.nasa.gov/SEgoogle/SEgoogle2001/SE2017Aug21Tgoogle.html>

<http://www.timeanddate.com/eclipse/solar-eclipse-frequency.html>

<http://www.alpo-astronomy.org/eclipse/observeeclipses/chapter9.htm>

<http://www.alpo-astronomy.org/eclipse/observeeclipses/chapt>

Mark Ryan

## Gunflint Trail ILSG trip

### ILSG Field Trip 7, May 7-8, 2016, Archean and Proterozoic Geology of the Western Gunflint Trail

Borrowing from the Field Trip Guide: 'This field trip along the western end of the Gunflint Trail explores Neoproterozoic, Paleoproterozoic, and Mesoproterozoic rocks, and a diversity of well displayed unconformable and intrusive contact relationships. In this area, the Neoproterozoic greenstone-granite terrane of the Wawa subprovince of Superior Province is represented by a succession of metavolcanic rocks (~2720 Ma) known informally as the Paulson Lake volcanic sequence, intruded by the Saganaga Tonalite (~2690 Ma) and Paleoproterozoic sedimentary strata of the Animikie Group (~1870-1830 Ma), which includes the Gunflint Iron Formation. The stratigraphic top of the iron-formation is marked by seismically deformed and brecciated strata and ejecta—known collectively as the Sudbury Impact Layer—that resulted from a meteorite impact near Sudbury Ontario (~1850Ma)" or 480 miles away.'

The most interesting part of the trip for me was the area affected by the Sudbury Impact. As you may remember, the area suffered a massive blow down in July 1999 which was one of the largest blow downs ever recorded in North America. Later, two forest fires (2006 and 2007) ravaged the area. After the major forest fires, Mark Jirsa from the Minnesota Geological Survey recognized the opportunity to investigate the area and discovered evidence of the Sudbury Impact 1,850 million years ago. We approached the area of interest from both ends of the Magnetic Rock Trail. The "Magnetic Rock" is a slab of iron-formation in which bedding is essentially vertical and standing nearly 30 feet above the surrounding land surface. So, was it up-ended by the glaciers but left delicately balanced intact during ablation? Mark believes that it was glacial rotation of a "cube" of rock, followed by spalling along bedding planes during repeated cycles of freeze/thaw (frost-heaving).

I have to mention that after Mark discovered evidence of the Sudbury Impact, the Magnetic Rock Trail area was swarming with people looking for meteors.

Unfortunately, there are no meteors or pieces to be collected.

We left the trail on several occasions which necessitated climbing uphill (with our tools and specimens) over blown down trees and fallen trees that had burned and were now charcoal to coat you and your clothes. Stop 11 – Paleoproterozoic ejecta and breccia from the Sudbury meteorite impact, intruded by sill and dikes of the Mesoproterozoic Logan Intrusions. "This traverse provides a cross-section through diabase of the Logan Intrusions and underlying deposits of iron-formation, breccia, and ejecta. The diabase is medium to coarse-grained in its core to the south, and grades to finer grained and more porphyritic near its base to the north. The northernmost outcrops lie along a steep cliff that



exposes the upper Gunflint Iron Formation overlain by a thick sequence of iron-formation breccia that represents



*Large fragment breccia, no ejecta*

the ejecta-ascent facies of the Sudbury Impact Layer. This is overlain by irregular lenses of bedded lapillistone, mesobreccia and reworked breccia containing rounded fragments of iron-formation in a matrix composed largely of accretionary lapilli that collectively represent the ejecta-bearing facies."

The last stop was an observation of folded siliceous and argillaceous iron-formation overlain by a thin, discontinuous layer of mesobreccia containing scant accretionary lapilli. The chaotic fold style indicates soft-sediment deformation prior to deposition of ejecta, which lends credence to the inference that iron-formation was not yet fully lithified at the time of impact.

The lapilli stone below, represents the only layer of thin



*Folded iron-formation*

ejecta from the impact.

I am sure that everyone enjoyed this trip. The weather was great and the lesson for me was that a camera with pictures is a lot lighter than a 26 pound bag of rocks.

Ted Chura



*Lapilli stone ejecta*

### Wind Cave and Jewel Cave

This past September I enjoyed an eleven-day camping trip through Colorado, Wyoming, and South Dakota. I'd like to describe just two of the wonderful geological sights I saw: Wind Cave and Jewel Cave in the Black Hills of South Dakota. They are both managed by the Park Service – Wind Cave as a national park and Jewel Cave as a national monument. Both provide multiple guided tours daily. For example, the popular Jewel Cave Scenic Tour involves walking up and down 723 stair steps along a 1/2 mile loop, (equivalent to 40 flights of stairs). Both caves are Karst caves – both formed by the slow dissolution of limestone by mildly acidic water and are immense – Wind Cave is the 6<sup>th</sup> largest in the world with over 140 miles of mapped passageways, and Jewel Cave the 3<sup>rd</sup> largest with 182 miles. Wind Cave was named due to the considerable wind at its natural entrance. All caves breathe, but it is especially noticeable here because the cave is so voluminous and its natural entrance so small (10" by 14"). The entrance constructed for visitors is protected by an airlock to keep this phenomenon intact. Wind Cave is notable for containing about 95 percent of the world's discovered boxwork – thin blades of calcite that project from cave walls or ceilings that intersect one another at various angles, forming a box-like or honeycomb pattern. Jewel Cave has, along with many other speleothems such as popcorn and flowstone, an abundance of dogtooth spar, a formation that consists of very large calcite crystals (the jewels in Jewel Cave) resembling dogs' teeth (hence the name). Especially beautiful is frostwork, which are fragile formations resembling ice crystals that grow in areas with lots of air movement; their needle-like growths are composed of aragonite or calcite replaced by aragonite. On your next trip to the Black Hills, which cave should you tour? Both, of course; you are a member of GSM for a reason!

Dave Wilhelm



For more photos, go to <https://get.google.com/albumarchive/100060900510377257166> and look for albums "CO WY SD 2016 Day 8 AM" and "CO WY SD 2016 Day 9".



*Left; Wind Cave,  
Natural  
entrance;*

*Right  
Wind Cave  
boxwork*

*Bottom-  
Jewel Cave  
specimens*



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